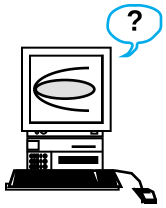


Ask Dr. ALOHA:

Some ALOHA Case Histories

Over the years, ALOHA® has been put to use by responders and planners around the world as well as in the U.S. What problems have people experienced when they used ALOHA? What successes have they had? In this issue, we'll look at some real-life case histories. All are examples of people using ALOHA for response or planning applications. In some of these cases, ALOHA proved to be a valuable tool for its users. In other cases, people encountered problems when they tried to use it. We'll identify some of the reasons why some people were successful ALOHA users and others weren't.

When ALOHA has been useful

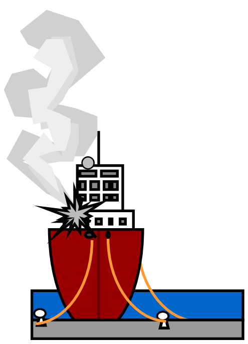
Hydrogen fluoride in a derailed tank car A railroad tank car filled with hydrogen fluoride derailed on the outskirts of Louisville, Kentucky. Before preparing to move the tank car back onto the tracks—an operation that could result in rupturing or puncturing it—Bud Fekete, hazards coordinator for Louisville and Jefferson Counties, used ALOHA to model a potential hydrogen fluoride release. An initial concern was that if the tank car ruptured, the hydrogen fluoride would escape as a two-phase flow. Such a heavy, dense cloud of pressurized gas and aerosol droplets is the most dangerous kind of release because, depending on conditions, concentrations may remain high within such a cloud for distances far downwind of the point of release. However, once he entered weather and source strength information, ALOHA quickly showed that on this cool morning in early November, the hydrogen fluoride, stored at the ambient temperature of 50°F, was well below its boiling point of 67°F. It would escape from the tank car not as a two-phase flow, but as an unpressurized liquid. This result alerted responders to expect a puddle of hydrogen fluoride to form in the event of a rupture and to consider diking as a response option—an alternative they might otherwise have overlooked.

Sodium hypochlorite at a sewage treatment plant Sodium hypochlorite solution, a water purifier, and sulfuric acid, which is used to adjust pH, are stored at a sewage treatment plant. These two chemicals, if mixed, will react violently to produce chlorine gas. The probable reaction is

$$H_2SO_4 + 2NaHClO \rightarrow Na_2SO_4 + 2H_2O + Cl_2.$$

An environmental consultant used ALOHA to estimate how much sodium hypochlorite could be stored at the plant without creating a significant chlorine exposure hazard to residents living beyond the plant's fenceline. To do this, he made the conservative assumption that all the sodium hypochlorite would react with the sulfuric acid to produce the maximum possible amount of chlorine. He used basic stoichiometry (a method that allows you to estimate the quantities of constituents involved in a chemical reaction) to estimate how much chlorine would be evolved from the reaction of a given amount of sodium hypochlorite with an unlimited amount of sulfuric acid. He assumed that the reaction, because it is violent, would last for just a few minutes. He then modeled the resulting chlorine release in ALOHA by entering worst-case weather conditions, then choosing the Direct source option, entering the amount of chlorine evolved from the reaction, and indicating that the release would be instantaneous[1]. For his level of concern, he chose chlorine's Emergency Response Planning Guideline-2 (ERPG-2), a toxic threshold that's appropriate for general populations (in contrast, the immediately dangerous to life and health, or IDLH, values in ALOHA's chemical library are appropriate for healthy adult workers). He obtained footprints for a range of amounts of sodium hypochlorite. In this way, he was able to estimate the maximum amount of sodium hypochlorite that could react with sulfuric acid without producing a chlorine footprint longer than the distance to the fenceline.

Ammonia and chlorine involved in a fire A ship caught fire while docked at the Port of Seattle. Initial reports indicated that the vessel contained 10,000 pounds of ammonia in tanks and possibly two 400-pound chlorine tanks. The Coast Guard requested modeling help from the NOAA / HAZMAT emergency response team. The team recognized that ALOHA would not be a useful tool for modeling the smoke plumes from the fire, since it was not possible to characterize the many combustion byproducts that would be contained in the plumes (in any event, these plumes were visible and could be accurately tracked by simple visual observation). But because the ammonia and chlorine tank temperatures were reported to be 500°F and increasing, the team recognized that the tanks could become hot enough to rupture and that if they did, ammonia and chlorine would be released immediately. They modeled each potential release in ALOHA by choosing the Direct source option and indicating an instantaneous release. The team used a portable weather station to monitor the on-site weather, and updated their ALOHA scenarios when necessary. As they interpreted ALOHA's footprint plot, they recognized that topographic effects would make both wind speed and direction less predictable (the area around the port includes both tall downtown buildings and shoreline bluffs). That meant that the area where an ammonia or chlorine cloud might be located would be larger than predicted by ALOHA. To account for this, they extended the footprint's length and width.



[1] Instead of indicating that the release was instantaneous, he now could use ALOHA 5.2 to enter a release duration of a few minutes.

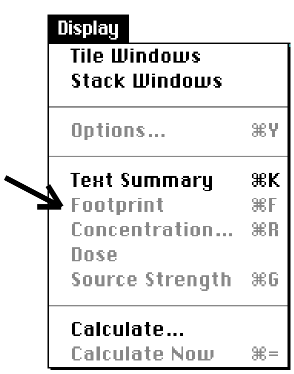
When ALOHA has not been useful

An indoor release Police officers investigating reports of an illegal drug laboratory found that a mixture of volatile liquids had spilled from broken containers and pooled at the bottom of an apartment building stairwell. One officer tried to use ALOHA to predict the dispersion of evaporating vapors within the building. However, ALOHA could not make useful predictions for this incident because it isn't designed to model indoor releases. Like other air dispersion models, it accounts for the large-scale processes that move and disperse vapor clouds within a turbulent atmosphere. The processes that disperse vapors in the much less turbulent air within a building are very different, and ALOHA does not account for them.

A release of refrigerated ammonia During a practice drill, an emergency responder tried to model the release of refrigerated ammonia from a broken pipe connected to a storage tank. The user selected ALOHA's "Pipe" source option, which is designed to model releases of pressurized gases from pipelines. However, refrigerated ammonia is liquid, not gas. This user needed to choose a different source option—ALOHA's "Tank" option—for this release.

A release of oleum from a tank car A tank car filled with oleum was being heated so that it could be offloaded. When a safety relief valve blew out, a cloud of hazardous vapor escaped. Emergency responders tried to use ALOHA to model this accident, but quickly discovered that oleum is not included in ALOHA's chemical property library. This common substance was left out of the library because it is a mixture of two chemicals, sulfuric acid and sulfur trioxide. ALOHA can model the dispersion of pure chemicals only, so its chemical library does not include any mixtures or solutions. Not recognizing that a substance is a mixture or solution rather than a pure chemical or not recognizing that ALOHA can model pure chemicals only are common errors made by ALOHA users.

A vinyl chloride release Shortly after a release of vinyl chloride from a tire factory, a team tried to run the incident scenario in ALOHA. They entered weather and source strength information. However, they were unable to obtain a footprint; they discovered that ALOHA's **Footprint** menu item was unavailable (as shown below).



ALOHA makes this menu item unavailable whenever there is no level of concern (which could be either a level of concern entered by the user or an IDLH value stored in ALOHA). Because no IDLH for vinyl chloride has been established, the user must enter some other level of concern to obtain a footprint for this chemical. Some other exposure limits that could serve as levels of concern are listed in the references listed at the end of this article. By doing a little research, the team would have found that the Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit

(PEL) for vinyl chloride. Current PELs are listed in Table Z: Air Contaminants, published in Title 29 of the Code of Federal Regulations, Section 1910.1000, and additional information about vinyl chloride can be found in Section 1910.1017. The same information, along with other information about OSHA standards, is available on the Internet at http://www.osha-slc.gov/OCIS/standards_related.html. According to OSHA, the maximum allowable amount of vinyl chloride in workroom air during an 8-hour workday in a 40-hour workweek is 1 ppm, and the maximum amount allowed in any 15-minute period is 5 ppm. The 15-minute limit of 5 ppm would have been an appropriate ALOHA level of concern for this release.

Some take-home points

These case histories show that whether or not ALOHA is a useful tool can depend on the skill of its user. People were most successful when they

- **recognized ALOHA's main limitations.** Not recognizing one of ALOHA's important limitations is one of the most common reasons why users have encountered problems. In some of these examples, people did not recognize that ALOHA can't model indoor releases or mixtures. In contrast, the NOAA/HAZMAT team modeling potential ammonia or chlorine releases from the burning ship were able to put ALOHA to successful use by recognizing what they could not model—the smoke plumes from the vessel—and focusing instead on what they could model.
- **had some understanding of the chemical being modeled.** ALOHA's most successful users typically have had at least some chemistry training and know that it's important to find out as much as you can about the chemical you're trying to model. The consultant assessing the hazards of stored sodium hypochlorite would not have been able to use ALOHA for his work if he had not recognized the potential of that chemical to react with sulfuric acid to produce chlorine gas. In contrast, the team attempting to model the vinyl chloride release would have been successful if they had looked up the levels of concern that have been established for this chemical.
- **had practiced with ALOHA and understood basic air modeling concepts**. One reason why the NOAA/HAZMAT team was successful in their use of ALOHA is because they didn't treat the footprint as an exact map of the hazardous area. They recognized that the circumstances of any release will almost always be at least a little different from what ALOHA expects. In this case, they recognized that the topography around the burning vessel differed from the flat terrain that ALOHA assumes. They adjusted the dimensions of ALOHA's footprint to account for this difference.

An air dispersion model like ALOHA can be a great help to you when you need to respond to an accidental hazardous chemical release or to plan for a potential accident. ALOHA can be especially helpful because it's designed for use in situations when time is short. For example, it contains a chemical property library so that you don't have to look up properties, and it lets you enter information in any of a variety of units of measurement, so that you don't need to convert from one unit to another. But although ALOHA is relatively easy to use, the science behind it is difficult to master. For that reason, as the people in some of these case histories discovered, it's not hard to make errors when you use ALOHA (or any other air model). The best way to ensure that you can use the model safely and effectively when you need to is to practice with it as often as you can and to become as familiar as you can with the basics of air modeling.

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